1.1 Methods of Science

I What is Physics?

A. Science is a method for studying the natural world

B. Physics: a branch of science that involves the study of the physical world.

→ energy and matter and how they are related

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1. The goal of Physics is to help you better understand the physical world

2. Physics involves many different scientific fields including: engineering, computer science, medicine, and astronomy

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II. Scientific Methods - the investigation procedures for science that follows pattern

A. State the problem - what am I investigating?

B. Research and gather information before beginning an investigation it is useful to research what is already known about the problem

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C. Form a test hypothesis

1. A hypothesis is a possible explanation for a problem using what you know and have observed

D. Analyze the data - an important part of every investigation includes recording observations and organizing data (tables, graphs)

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1. Many important discoveries have been made from unexpected results
2. Scientific inferences are based on scientific observations and all scientific explanations must be considered

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E. Drawing conclusions- based on the analysis of data, the next step is to decide whether the hypothesis is supported

F. Peer review – before science based information is reviewed by scientists' peers

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1. process ensures that research findings are valid

G. Being objective – it is important to reduce bias in an investigation

III Models – helps scientists visualize things they cannot see when they are testing

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A. A model is a representation of an idea, object, event, or structure that helps people better understand
   1. Historically, model has helped develop their understanding of the atom
   2. High tech model- computer simulations are effective models

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IV. Scientific Theories + Laws

A. Scientific theory - an explanation of things or events based on knowledge gained from many observations + investigations

B. Scientific Law - a statement about what in nature and seems to be true all the time

1. Laws tell you what will happen under certain conditions, but don't explain why or how something happens

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C. A theory can be used to explain a law, but theories do not become laws

V. Limitations of Science

A. Science can help you explain many things about the world, but science cannot explain or solve everything

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1 A paper airplane could be considered a scientific _____

A law
B method
C model
D theory

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2 The first model of the atom was developed by Einstein

True
False

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3 Which of the following questions is not scientific?

A Why does the sky appear blue?
B What elements are found in stars?
C What is the best pizza topping?
D How far is it from New York City to Denver?

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4 A scientific law is _____

A a statement about what happens in nature and seems to be ture all the time
B an explanation of things based on knowledge gained from many observations and investigations
C a representation of an idea, event, structure, or object that helps people better understand it
D a possible explanation for a problem knowing what you know and have observed

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5 Which statement is false?

A Models can be used to study very small objects and very large objects
B a scientific thoery can become a scientific law
C scientific theories can be refined as new information becomes available
D science cannot explain everything

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6 Unexpected results from a scientific experiment are not meaningful

True
False

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1.2 Mathematics and Physics
→ we use math to explain concepts in physics
→ review vocab: SI units: universally accepted version of the metric system

I. Math in Physics
A. Physicists often use the language of math

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B. Equations are important tools for modeling observations and for making predictions

II. SI Units - to communicate results, it is helpful to have a common language of measurement everyone understands

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III Dimensional Analysis-
the method of treating the units as algebraic quantities that can be cancelled
→ Example: convert 43 km/h to m/s

$$\frac{43\,\text{km}}{1\,\text{hr}} \cdot \frac{1000\,\text{m}}{1\,\text{km}} \cdot \frac{1\,\text{hr}}{60\,\text{min}} \cdot \frac{1\,\text{min}}{60\,\text{sec}} = \frac{43000}{3600}\,\text{m/s}$$

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IV Significant Figures - the valid digits in a measurement
→ Example: you estimate the pen is 1/10th of a millimeter past 138mm, so you record the pen as 138.1mm. Since the last digit is uncertain, you only record 3 sig figs → 138mm

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A. Are all zeros significant? No
→ Example: 0.0860 m, the first two serve only to locate the decimal point and therefore are not significant

B. Arithmetic with sig figs
1. When you perform any arithmetic operation, it is important to remember that the result never can be more precise than the least precise measurement

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3.79 + 2.473 = 6.26

409.2 / 11.4 = 35.9

1.093 + 0.42 = 1.51

22 / 11.94 = 1.85

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V Solving Problems - a 3 step process

A. Analyze + sketch the problem
1. Read the problem again
2. Identify what you are given, and list the known data
3. Identify and list the unknowns
4. Determine whether you need a sketch to help solve the problem
5. Plan the steps you will follow to find the answer

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B. Solve for the Unknown
1. If the solution is mathematical, write the equation and isolate the unknown factor
2. Substitute the known quantities into the equation
3. Solve the equation
4. Continue the solution process until you solve the problem

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C. Evaluate the answer
1. Reread the problem. Is the answer reasonable?
2. Check your math. Are units + sig figs correct?

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1.3 Measurement
→ Main idea: making careful measurements allows scientists to repeat experiments and compare results
→ parallax: the apparent shift in position of an object when it is viewed from different angles

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I. What is a measurement?
A. A measurment is a comparison between an unknown quantity and a standard
II. Comparing Results - scientists share results

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A. Before new data are fully accepted, other scientists examine the experiment + look for possible sources of error and try to reproduce the results
III. Precision vs Accuracy
A. Precision - the degree of exactness of a measurement

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1. precision depends on the instrument + technique used to measure

B. Accuracy - describes how well the results of a measurement agree w/ the real or accepted value

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1. A common method for checking accuracy of an instrument:
   a. does instrument read zero when it should
   b. does it give the correct reading when it measures an accepted standard

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IV Techniques of Measurement

A. to assure accuracy + precision, instruments also have to be used correctly

B. GPS - Global Positioning System
   * Geocaching

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1. Consists of 24 satellites w/ transmitters in orbit and numerous receivers on Earth
2. Developed by U.S. Department of Defense

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1.4 Graphing Data

→ Main idea: graphs make it easier to interpret data, identify trends, and show relationships among a set of variables

→ Review Vocab: slope - rise/run

I. Identifying Variables

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A. When you perform an experiment, it is important to change only one factor at a time

B. A variable is any factor that might affect the behavior of an experimental set-up

1. Independent variable - factor that is manipulated during an experiment

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2. Dependent variable - the factor that is affected by the change in the independent variable

C. Line of best fit -

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C. Line of best fit: the line on a graph that is drawn to all the data points as possible

1. a line graph shows how the dependent changes with the independent variable

III. Linear Relationships

A. 3 most common relationships include: linear, quadratic, and inverse

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B. In a linear relationship, the dependent variable varies linearly with the independent variable

1. Linear relationship= $y = mx + b$
   a. y-intercept = b, slope = m
   b. rise/run = $m = \frac{\Delta y}{\Delta x}$

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IV Non-linear Relationships - many types of non-linear relationships, but two are the most common

A. Quadratic relationship - exists when one variable depends on the square (x^2, etc) of another
   1. $y = ax^2 + bx + c$

B. Inverse relationship - is a hyperbolic relationship in which one variable depends on the inverse of the other variable

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V. Predicting Values

A. When scientists discover relationships they use them to make predictions
   1. Physicists use models to accurately predict how systems will behave

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